X. *Some notes on the* Micro-Lepidoptera *whose larvæ are external feeders, and chiefly on the early stages of* Eriocephala calthella (*Zygænidæ, Limacodidæ, Eriocephalidæ*). By Thomas Algernon Chapman, M.D., F.E.S.

[Read Feb. 7th, 1894.]

Plates VI. & VII.

I present these notes now, as there seems little probability that I shall, at an early date, be able to carry further my observations on *Eriocephala*, and it is desirable to put them, so far as they go, at the disposal of anyone who may wish to continue them; and I present along with them sundry notes that tend to confirm the view, that the *Zygænidæ*, *Limacodidæ*, and *Eriocephalidæ* form a group which, though the last member is as low as the lowest *Tineæ*, and the first as high as Butterflies or Noctuæ, has nevertheless been evolved on its own lines, from a common source, as a separate branch of Heterocera.

The broad facts of the pupal structure, and the slug-like form and habit of external feeding of the larva, probably suffice to support this view; but further points of alliance are no doubt most useful in confirmation.

It becomes necessary, in the first place, to relate my observations on *Eriocephala calthella*, since it is largely to these observations that I owe the confidence I feel that this grouping of families is justified by fact.

The genus *Micropteryx* was divided by Stainton ("A Monograph of the British Species of the Genus *Micropteryx* of Zeller," Trans. Ent. Soc. Lond., new series, vol. i., pp. 26–40, 1850–1) into two sections—A. *Eriocephala*, of Curtis, and B. *Micropteryx*, Hübner. At that time the larvæ were unknown, and the division was made by the neuration. Shortly after, the larva of *Micropteryx*, Hübner, was discovered, and very soon material was accumulated that would have justified what must now be done, viz., separating the *Eriocephalæ* from the *Micropteryges*, not only as a distinct genus but as a separate

family; and the following might be a brief outline of the characters, distinguishing them from each other and from other forms.

Micropterygidæ. Ovum: Ovoid in shape, delicate, transparent, and nearly colourless; laid in the parenchyma of a leaf.

Larva: Leaf-mining, without legs.

Pupa: In a dense subterranean cocoon, escaping therefrom for emergence; segments of abdomen all "free;" has large jaws, used for assisting the pupa out of cocoon, like those of *Trichoptera*, but larger and more elaborate.

Imago: Large six-jointed maxillary palpi, no trace of jaws, 9th and 10th abdominal segments of ♀ form a knife arrangement for piercing leaves for oviposition; 8th is an external ordinary (but terminal) segment. (In *Adelidæ* the 8th is absorbed in the piercing apparatus, and the 7th is the external terminal segment.)

Eriocephalidæ. Ovum: Spherical, opaque, covered with a snow-like coating, laid externally.

Larva: Short, square, and angular, with 8 rows of globular appendages, and 8 pairs of abdominal legs, an anal sucker, long antennæ, feeding exposed.

Pupa: (Probably not unlike a *Nepticula*, and in a cocoon above ground.) I have only seen the head and antenna piece, and cannot build up the whole pupa from that with any confidence.

Imago: Six-jointed maxillary palpi, used as feeding hands: well-developed, serviceable jaws; ovipositor simple, tubular, of three pieces, last abdominal segment the 7th. There is also the neurational difference noted by Stainton.

I propose, then, to accept and accentuate this division, leaving the name *Micropteryx* for the "higher" group, whose larvæ have been known for so long, and as to whose oviposition and corresponding structure of the imago I had the pleasure of assisting my friend, Dr. Wood, in his researches, though in view of my observations on their pupæ, I think it must be very doubtful whether they can be called the "higher" group any longer.

The *Eriocephalidæ* attracted my renewed attention when engaged in working out the oviposition of the *Micropteryges*. In the far-off days, when the life-histories

of *Micropteryx* were being recorded in the "Annuals," I was much impressed with the resistance of the *Eriocephalidæ* to investigation; but looking, as I then did, on the *Tineina* generally as subjects fit only for the work of past masters, I had little idea that they would continue this resistance for so many years, and that it would be left for me to make the first impression against it.

It was evident, on comparing the structure of *calthella* with that of *purpurella*, or other *Micropteryx*—as indeed it was to a great extent without that knowledge—that the habits of *Eriocephala* must be very different from those of *Micropteryx*.

I believe my observations have been made on both *calthella* and *seppella*, and I have not always been very careful to determine which species I had in hand, and may have had others. But in the observations I have made I have not determined that any decisive differences were observable.

In *calthella*, then, the ovipositor is quite short, simple, and tubular; no knives, or rods, or other complex apparatus, as in *purpurella*. The egg, therefore, must be laid in a very easy, simple way. This is confirmed by noticing that the egg is large and spherical, not, therefore, to be slipped into any narrow chink or crevice. It seemed also certain that it was not laid on the leaves of any plant, so I assumed it must be laid in moss or rubbish, on the ground. By providing a number of moths with such materials in May, 1891, I succeeded in obtaining a large number of eggs, and in hatching the young larvæ; but I altogether failed to induce them to eat. The egg and young larvæ are, however, so very remarkable—so unlike all our ideas of a Lepidopterous insect—that even so meagre a measure of success was worthy of note. I delayed doing more than mention the result for two reasons. Firstly, because one of our leading—perhaps I ought to say our leading lepidopterist—was pleased to suggest that the beast I had under observation was an *Julus*, or a Crustacean, or some unknown monster, and that repetition was very desirable, with many precautions, to make sure I had *Micropteryx*, *i.e.*, *Eriocephala*, and nothing else. This advice I was very willing to follow, because not only was it obviously a great compliment to the extraordinary nature of the observation, but as a second reason for delay I hoped to

be able to make my observations more full, and even perhaps to rear the larvæ.

I accordingly, in June, 1892, secured a good supply of moths and placed them in many different jars. In three of these I gave them nothing but moss, which I had obtained in winter, then cleaned and boiled it, and kept it in a dry condition until it was wetted and given to the moths. Eggs were freely laid in this sterilised moss as in the other jars. I may say that I myself considered this precaution to be absolutely unnecessary, as the eggs laid agreed precisely in size and form with those dissected from the moth—they were seen against the deceased moth that had laid them, they were laid in several different jars, and finally Dr. Wood had, by repeating my procedure, induced moths to lay, and had in fact confirmed all my observations. However, the sterilised moss experiment has been made successfully, and several dozen batches of eggs have been laid, so that there is no room for the most severe scepticism to suggest a doubt.

In 1892 I supplied the moths with flowers of *Ranunculus repens* (common buttercup), and though I believe observations have been made on the mouth-structures and habits of these moths, in which they are in truth very anomalous, as in so many other ways, I may mention my own observations. They use their great claw-like maxillary palpi with sharp knife points to scrape and tear at both the pollen of the stamens and the surface of the petals, in the latter case perhaps collecting fallen pollen. They certainly do something very like eating as regards this pollen, and digest and use it, as would appear from two circumstances: firstly, that very slender moths get very fat and lay many eggs, and, secondly, their dejecta are very abundant. There is obviously room for much detailed observation in this matter, which I did not make, as I wished all my material to be devoted to making sure of eggs, and I had not too much time to give to the subject.

Moths will live in confinement for three weeks if fed in this way and kept damp enough.

They pair readily, and apparently do so more than once. When laying, the female moth creeps down among the moss to a depth of an inch or more, and seems anxious to get to the bottom and lay her eggs on the bottom of the jar, sand or earth. If the stratum is

too deep for this she will lay them on a spray of the moss, always in little groups, rarely as few as two or three, usually six to ten and even more. I have counted as many as twenty-five. She will often remain and die beside her last batch of eggs. I prepared various jars with mosses of different sorts, and especially several with growing *Mnium*, which I thought might be the proper food, but in this I proved to be mistaken.

About the middle of August, 1892, I found several larvæ of *calthella* about 1·5 mm. in length in a jar in which some moss was growing, but I could see none in my specially prepared pots of *Mnium*, nor indeed in any of the other jars; these larva, though so much larger than the newly-hatched ones, were precisely the same in all respects, so far as I could see without disturbing them. They were kept very wet, the moss dripping and the sand below under water, in consequence of my directions to keep them moist during a temporary absence being misunderstood. The result, however, was decidedly satisfactory, and at the end of September the moss was still growing, and there were two larvæ usually to be seen of a length of about 2 mm. On October 21 I found there were three larvæ in this jar, the two largest measuring with the head retracted 3·5 mm. in length, and therefore probably full grown.

I also found several about 1·3 mm. in length in another jar in which moss was growing, but which had been kept much too dry. In one of the *Mnium* jars there was also one about 1·5 mm. long, seen for the first time close by where a bit of moss (not *Mnium*) was growing. I was on this date successful in making two other observations. One was in seeing one of the larvæ in my best jar actually eating the delicate stem of growing moss, of which a considerable piece of one side had disappeared. The other was due to one of the larvæ having got on to the glass, when not only was it easy to see that it resembled the newly-hatched larvæ as to processes, abdominal legs, etc., but that it also possessed the trefoil sucker. These larvæ seemed to be constantly on the move, at times not to be seen, and when seen always in a fresh place; they walk slowly but steadily, using the abdominal appendages as legs, and often raising the fore part of the body and stretching about as if in search of something.

They are not cannibals, as one walked straight along

another and neither attempted to injure the other in any way. As judged by the sizes of their heads, there were at least three sizes of larvæ on October 21st, which with the newly-hatched one makes four sizes; but there is little doubt that there would be one or two intermediate sizes between the young larvæ and the smallest seen at this date. The intestinal contents, so far as they are visible through the larva, were in one instance green, in two others brownish. Occasionally a good end view of the larva is seen, and then its angularity (on cross section) is very evident, the spaces between the double rows of processes being hollow and the processes placed on the angles of a flat, raised surface. None of the drawings I have bring out this peculiarity quite satisfactorily.

These larvæ preserve also the long antennæ; these have an elegant curvature, and are placed on the head so as to look, as it moves from side to side, ridiculously like the horns on a Hereford ox—the proportionate length of horn to head being not very different in the two cases.

The moss on which these larvæ thus happened to be reared was named for me by the Rev. A. Ley as *Hypnum prælongum*, a common species. There were also present, though it was doubtful if these were growing, two other common species, *Hypnum tamariscinum* and *swartzii*, and possibly others.

I must admit that I was nearly as much astonished at finding the full-grown larva retain the peculiar structure of the young larva, as I was when I first saw the newly-hatched larva. Having so few and wishing very much to obtain the pupa if possible, I did not sacrifice any of these, for closer examination; but one that died, of 2·5 mm. long, though not quite satisfactory, gave me a good view of the abdominal legs and ball appendages; the head was unfortunately retracted and could not be satisfactorily made out. All these larvæ perished during the winter, and left no trace, except some remains that make a rather poor slide.

In 1893 I prepared eight jars with various mosses and succeeded in having plenty of eggs laid in them, but for some reason or other the young larvæ, which hatched abundantly, appeared to have all perished, until I was pleased and surprised early in November to observe two full-grown larvæ in one of the jars.

In January, 1894, I observed some threads of *Isaria* in this jar, and found they proceeded from what turned out to be a cocoon of *calthella,* with a dead full-grown larva curled up inside; the cocoon was fairly tough, of yellowish silk and with scraps of moss coating it, ovoid, 3 mm. long and 1·5 broad. The contained larva was somewhat damaged by the fungus and in removing it from the cocoon. The abdominal legs are all present, but the structure seems a little more modified, either really or by the *Isaria,* than in the two-third grown larva already referred to. The antennæ are very long, the first long joint being very long, the second reduced as compared with younger larvæ. The ball appendages are proportionally rather smaller. The dots in the sulci between are now large, round, smooth, disc-like plates, comparing markedly with the rough surrounding skin, and having a central pigment spot.

The ova are spherical, 0·46 mm. in diameter, of *calthella* almost white; of *seppella* 0·41 mm., a very little smaller and distinctly yellow. They have a snowy, mealy look, owing to a provision of a close coating of minute rods standing vertically on the surface of the egg and often tipped with a small bulb (of fluid?); whether these are adpressed to the surface of the egg when laid, or whether they afterwards develop in some way, I do not know, but I think the latter. Their function would appear to be to protect the egg from too close contact with the possibly very wet surface on which it lies.

The young larva is difficult to examine owing to its delicacy, to its retracting its head when disturbed, and to its rapid shrivelling by desiccation, when removed from its natural habitat in damp moss.

The peculiarities of its form and structure may be stated to be its angular outline, the possession of a number of remarkable appendages to each segment, of eight pairs of abdominal legs of unusual structure, and of an oval sucker; that the antennæ are remarkably long for a lepidopterous larva, and that the head is retractile, so far, that it may occupy the interior of the 2nd thoracic segment.

The larva does not appear to alter these characters during its growth to maturity. The antennæ of the adult

larva are not perhaps proportionately so long, and the abdominal legs have shorter and thicker bases.

The description, therefore, and figures of the larvæ, though chiefly taken from preserved specimens of the young larva, are not probably far out, if applied even to the full-grown one.

The larva is thick and short and fairly cylindrical, apart from its angular section, and tapers very little, terminating rather abruptly at either end, especially when sulky and with retracted head. The angular outline is due to eight rows of peculiar appendages, so disposed as to form two subdorsal rows and two lateral rows on either side, each double row arising from the angles of a raised ridge, and the intervening spaces being rather hollowed. The general surface is raised in ridges, or rather marked by sulci that are chiefly transverse in direction, but communicate with each other to form a network, and in places forming a beautiful rosetted pattern.

The general result is a division of each segment into five subsegments, the balls or appendages are on the third of these. The fourth and fifth, in the centre of the dorsum, and again in the centre of space between the subdorsal and lateral pairs of ridges, are united into one by a circular area, in the centre of which is a dot or spot.

This description applies to the 2nd and 3rd thoracic and 1st to 7th abdominal segments. The 1st thoracic segment has two transverse rows of ball appendages, with six in the first row and four in the second.

On the 8th abdominal segment the appendages are similarly in two rows, but deficient in number, there being only eight altogether; whilst on the 9th segment are only six.

These appendages on 8 and 9 abdominal are longer, larger, and more club-shaped, and project backwards from their points of attachment; those on the other segments shorter and more rounded, are directed forward—those on the 1st thoracic are, however, similarly a little larger and longer than the others.

These appendages arise from special ball-like points, encircled by a special area, and are globular in form, or in some cases nearly pyriform, with a definite neck or stalk; they are dotted as though with spiculæ in a rect-

angular pattern, and appear to have some internal ribbing or skeleton, which remains stiff in a mounted specimen, whilst the surface loses its plumpness and shrivels. The abdominal legs are eight pairs on the first eight abdominal segments, arranged so as to suggest that this double row is a modification of the double rows of appendages on the upper surface.

These legs are, however, of a very different structure from the balls of the upper surface, and also from the true legs on the thoracic segments.

They consist of a long stem or shaft with, both towards its base and apex, some doubtful spicular projections; this shaft is apparently cylindrical, and contains a body which is either a vessel or tube, or a tendon to the terminal claw. The shaft arises from a conical base, to which it is not distinctly jointed, but is rather continuous with it.

The terminal piece is a very distinct and separate structure, in general outline much like the terminal joint or claw of a thoracic leg, but with the sharp apex rounded off; the convexity is directed forwards (not inwards). It is of homogeneous semi-transparent texture, but marked by oblique lines, which suggest, whether correctly or not I cannot say, that the surface between them is raised in rounded ridges, which pass round the anterior and posterior edges and make it look like a conventional cornucopia. In preserved specimens the shafts of these legs seem laterally compressed.

Another structure is a sucker on the under surface of the 9th and 10th abdominal segments, its form is trefoil with one leaf forwards, or possibly only on 10th, the 9th being very narrow in front of it.

This sucker, on a lepidopterous larva, is of course very unusual, and is a further point of relationship to Limacodids. The 14th segment carries dorsally two hairs. The true legs, besides the base, which is a little full and raised, consist of three joints, and much resemble the thoracic legs of an ordinary lepidopterous larva. The first large joint has two spurs on its inner margin, about the middle, and two or three hairs on the same zone, laterally and dorsally; the second more slender joint is rather longer, and narrows about the middle, where there is a spur or bristle on its inner margin; on the outer side, at its extremity, is an indication of a bristle or two,

but no definite appendage. The last joint is again rather shorter, and terminates in a sharp point.

The head is rather longer than broad, and narrows a little forwards; there are two strong mandibles, with four brown teeth. The antennæ are very long, about equal in length to the transverse diameter of the head; there are two short thick basal segments, as to the first of which I am not very sure whether it is a true segment or a basal projection; there are two long segments about equal in length, and a nearly as long terminal joint, which is little more than a seta in thickness. Two pairs of palpi are also visible—two and three-jointed, apparently those usual in lepidopterous larvæ, but I have not defined their relations. There is also a central point (spinneret?).

I have also one observation bearing on the pupa. A moth that I placed on a slide was found to have a defective antenna, and was accompanied by the head-piece of the pupa case, which was of the "Incompletæ" or "Micro" type, that is, consisted of the covering of antennæ, head, and head-appendages in one piece. This observation renders tolerably certain what was antecedently probable, that the pupa is of "micro" type, with 3rd and following abdominal segments free.

The pupal structure of *Zygæna* and of *Limacodes* showed them to be micros, of a rather early type, whilst their ova also presented peculiarities nowhere to be met with among macros, and though not at all resembling closely those of *Eriocephala*, not at all unlike some Adelids.

The larvæ of these two groups, however, present very wide differences from other micros.

The only other micro-larva having similar form, and the habit of not mining or feeding internally, or under a web, was curiously that of *Eriocephala*. Unfortunately, though the pupa of *Zygæna* and *Limacodes* are of nearly the same micro-type, and that a low one, and *Eriocephala* must also have a pupa of low micro-type, I have, after trying to obtain it for three years, failed to do so. It cannot be taken for granted that it is of the same type as they are. We are therefore deprived, for the present, of the light that would throw on these relationships. It occurred to me, however, that if this relationship was real, and not a mere resemblance, some other points

of similarity of structure and habits would be discoverable.

The first point that occurred to me was that traces of abdominal legs, like those of *Eriocephala*, might perhaps occur in newly-hatched larvæ of some species of *Zygæna* or *Limacodes*. So far, I have failed to detect such a structure, but find it recorded that the larva of *Lagoa crispata* possesses additional abdominal legs. I have not yet succeeded in obtaining eggs of this species. The pupa is unquestionably *Limacodid*, though Packard calls it a *Liparid*. Though many systematists consider Liparids and Limacodids to inosculate, the pupæ prove them to be about as far apart, phylogenetically, as they well can be. I succeeded in obtaining eggs and young larvæ of *Parasa chloris*, and in rearing one larva; but though this is a most curious and interesting larva, it did not present any extra abdominal legs. It confirmed, however, the observations on *Limacodes testudo*, which afforded me some very curious facts, and some very unexpected confirmation of the suspected relationship to *Eriocephala*.

Limacodes has suckers to the first eight abdominal segments, though the first and last of these are poorly developed; these suckers are probably homologous with prolegs, and also with the eight pairs of abdominal legs of *Eriocephala*.

When the larva of *Limacodes testudo* has completed its development within the eggshell, which is very easy to watch, owing to its transparency, flatness, and the facility with which the moth can be induced to lay them on glass, it is free from any spines or processes, but at the period of hatching certain long spines are rapidly developed; of these there are at least four on each segment, arranged as a dorsal and lateral series on either side. The ordinary tubercles can be detected as faint dots, but these spines are quite independent of the ordinary tubercles, and differently placed, and correspond in position to no larval processes I am aware of, except those of *Eriocephala*.

In *testudo* the dorsal series on one side, though consisting of one spine on each segment, has them placed as though they were the double rows of *Eriocephala*, with alternate spines omitted, *i.e.*, the inner spine is wanting on the first abdominal segment, the outer one on the

second, and so on alternately; laterally the spines appear to belong to the lower row of the lateral series of *Eriocephala*, but the upper row is represented on the thorax by two spines.

A further point of resemblance in these spines to those of *Eriocephala*, is in their peculiar spiculate apex, which reminds one much of the peculiar stellate spiculæ of the knobs of *Eriocephala*.

The rapid development of these spines occurs in this way: In the unhatched larva a circular mark exists at the site of each spine, and is the summit of a cylindrical body deeply imbedded in the larval substance. This body is, in fact, the spine, of which the upper third appears to be already stiff and solid, with its apex at the surface ready to emerge, whilst the lower two-thirds form a soft invaginated sheath surrounding this upper part. As the spine emerges, when half of the soft portion has emerged there appears upon it a spur, and when the emergence is complete, and, in fact, at any time, a distinct joint is visible at the base of the upper portion. The soft portion appears very rapidly to become hard.

I had the good fortune to observe this emergence take place in many instances, and have preserved specimens at all the stages.

These spines are in length about equal in length to the diameter of the larva, and are divisible into three portions. The basal is rather thick and smooth, and terminates at the lateral spur. The middle portion is continuous with the basal, and is structurally the same—only narrower—and is also quite smooth. The terminal third is separated from the middle portion by a joint, or transverse line of union, and has a series of minute points or teeth, apparently arranged in a somewhat spiral manner along its shaft, and terminates at the apex in a slight enlargement and a coronet of angular points, six to nine in number. The lateral points are difficult to see except where taken in profile, though I have some preparations showing them to be really rather numerous and spirally arranged. Like the structural framework of the knobs of *Eriocephala* they are less evident during life.

The inner structure of these spines has all the appearance of consisting of a separate included tube running the whole length, and having a branch to the lateral spur.

On the first moult these spines disappear, and are

replaced by straight spines, that is, they have a smooth outline, and taper continuously from base to apex. They have, however, a joint about $\frac{3}{5}$th of their length from the base, the apex looking harder, browner, and more solid, and they appear to have a central tube. I need not allude to their apparent origin from deep tissues, and the skin looking like a thick coating of glass, through which they come, as this is, I think, a well-known peculiarity of these larvæ (as also of many Lycænids).

But the dorsal set of spines are now double, that is, the double row, of which the alternate members were wanting in the larva of the first stage, is now complete, and they remain so even in the adult larva, though they are now merely prominences, and not spines. In the second and third stages there are, especially in the thoracic regions round the bases of these spines, very minute spines, apparently of a structure very similar to the last joint of the spines in first stage.

The spinneret in this larva is remarkable up till the penultimate stage, in being not a pointed organ, but flattened out like a fish's tail, and the silk it disposes on the leaves for the larva to walk upon, is not a thread, but a very thin ribbon.

This larva has other very interesting peculiarities, most of which are, I imagine, well known. These I need not touch on, indeed all I am at present interested to touch on is the remarkable disposition and structure of these spines in the newly-hatched larva, parallel with nothing I know of in any other family than the similar arrangements in *Eriocephala*.

Prof. A. S. Packard has some excellent observations on spines of *Limacodids*, but on none, so far as I know, that quite parallel these in structure; and he does not, I think, refer to their disposition in the newly-hatched larva as similar to that I find in *testudo*.

He figures, however, the young larva of *Lithodia fasciola*, which seems to be very like that of *testudo*, though less well-developed, and for this reason, want of sufficient material, and insufficient amplification, appears not to have noted any of the points I have here drawn attention to.

Among many figures he gives of *Ceratocampid* and other spines, and similar figures elsewhere, and amongst my own observations, there are abundant instances of an

inflated or elongated base, carrying an appendage articulated to it, or several such; but these appendages are always simple hair-like or spinous, just as they are in *testudo* after the first skin.

In the case of *Zygæna* I have failed to detect any structures in the young larvæ I have examined at all parallel to these, and must still rely on the structure of the egg, the form and habit of the larva, and the very primitive form of the pupa, for its alliance with this section.

I have examined the eggs of *Limacodes testudo*, *Heterogenea asellus*, and *Parasa chloris*. They are all flat, oval, colourless, transparent, with lozenge-shaped network of cell-structure of the shell, easily seen if examined in suitable light and with moderate magnifying power. Such eggs occur amongst the Micros and in some Pyrales. Nothing like them is anywhere met with, so far as I know, amongst Macros.

The pupa also is of evident Micro type. The wing and appendage cases are not attached to abdominal segments beyond the second. They are not difficult to detach, in some species, from each other. The *maxillæ* are small, but are prolonged outwards, and after passing through a narrow neck terminate in a (sometimes rather twisted) club between the eyes, antennæ, and legs. This represents the maxillary palpus, which nowhere in Macros has any such development.

Then movement exists in the 3rd and 4th abdominal segments and in the ♂ pupa, also in the 7th. Further, the larva lies unchanged in the cocoon all winter, and moults to pupa in the spring, and the pupa escapes from the cocoon for emergence.

These characters apply to the following species which I had alive last spring: *Limacodes testudo*, *Parasa chloris*, *Limacodes scapha*, *Heterogenea asellus*, *Empretia stimulea*, and *Lagoa crispata*.

I do not know that a detailed description of each would carry us much further. They vary in the proportion of parts, the extent of toothed armature on the back of the abdominal segments, and other sculpture. Other features that do not so much interest us in the present connection are the possession of a beak between the eyes (for rupturing the cocoon); the projection backwards of the meso-scutellum, so that its sharp apex almost

reaches the 2nd abdominal segment; a very remarkable structure that exists in other families, but nowhere else so well developed as here, and which I have called an eye-flange. Where, in most pupæ, the eye abuts against the antennæ, it is here rather separate, and a flat flange-like margin, with sharp edge, and in some marked with radiating lines, surrounds the eye without quite joining the antenna.

In *Lagoa crispata* the antennæ of the male are a very marked feature of the pupa. Unfortunately, I had only this one pupa, and so failed to obtain eggs. The cocoon is very like the others except in one very important point, it has a practicable lid.

In *Zygæna* the egg is of an ovoid form, with a delicate colourless and apparently structureless shell. The contents divide into two portions—a yellow at one end, and a nearly colourless at the other, and till one is familiar with them one is persuaded they are addled at least.

The pupa (I have examined *filipendulæ, loniceræ, trifolii, exulans*) is very different from that of *Limacodes* in form and colour, but in the most essential points the number of free segments, the looseness of attachment of the appendages, and in the dehiscense, it is practically identical. The maxillary palpus is nearly or quite obsolete, and in some other points the appendage-cases have a structure differing from *Limacodes*. The dorsal head-cover is still well-developed.

I may note that *Syntomis*, placed in *Zygænidæ* or left close by in *Syntomidæ*, not only has, as has been often remarked, a very Arctioid larva, but, as is demonstrated by the pupa, is really an *Arctia*, with no affinities whatever with *Zygæna*. The ovum is also an *Arctia* ovum, not indeed very far from *Caja*, but differing from *Zygæna toto cœlo*.

I am indebted to Dr. W. G. Clements for the privilege of examining a cocoon and pupa of *Euchromia fulvida*, a species also credited with Zygænid affinities. The pupa in no way resembles *Zygæna*, but though very delicate and transparent, affords no characters that I can certainly seize to separate it, much more than generically, from *Lubricipeda*.

It presented a curious Arctioid peculiarity, viz., the adherence of the cocoon to the pupa. *Caja* cocoon, for

example, can hardly be touched without the cocoon adhering to the pupa, as if they had been wetted.

These two instances seem as sufficient as a thousand, to illustrate that *Zygæna* has been placed among Arctiid families, on the strength of some analogies of the imagines, which cannot be homologies, as they do not affect the earlier stages.

Explanation of Plates VI. & VII.

PLATE VI.

Larva of *Eriocephala calthella.*

Fig. 1. Larva first skin, slightly grown, dorsal view, × 100 diam.
2. Larva first skin, newly hatched, dorsal view, × 50 diam.
3. „ „ lateral view, × 50 diam.
4. Antenna, × 600 diam.
5. Abdominal leg, × 900 diam.
6. „ „ × 1200 diam.
7, 8. Ball appendages, × about 900 diam.

PLATE VII.

Eriocephala calthella.

Fig. 9. Ball appendage and rosetted structure of skin, half-grown larva, × about 300 diam.
10. Thoracic leg, × about 200 diam.
11. Abdominal leg of larva, two-thirds grown, × about 300 diam.
12. Ova in moss, × 30 diam., the upper ovum near hatching.
13. Form of sucker, ventral aspect of 13th and 14th segments.

Larva of *Limacodes testudo.*

Fig. 14. Newly-hatched larva, dorsal view, before emergence of spines, × 100 diam.
15. „ „ lateral view, × 100 diam.
16, 17, 18. Stages in emergence of spines, × 100 diam.
19. Terminal portion of spine, × 150 diam.
20. Thoracic leg, × 150 diam.

Fig. 1 from drawing by Mr. A. Hammond, F.L.S., from a living larva.
Figs. 2 and 3 from drawings by Mr. H. Knight, from living larva.
Figs. 5, 8, 9, 14, 15, 16, 17, 18, 20 from drawings by Mr. E. Wilson, from preserved specimens.
The others from my sketches.